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METAL COMPOSITION AND BEARING

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This invention relates to sintered copper base metal compositions, and bearings made therefrom.

An object of the invention is to improve copper base metal compositions and bearings.

This application is a continuation in part of our co-pending application Serial No. 333,928, filed May 8, 1940, now matured into Patent No. 2,372,202, issued March 27, 1945.

Other objects of the invention will be apparent from the description and claims.

Sintered metal compositions present a number of advantages over cast and wrought materials for several applications. The metal powders can be molded into intricate shapes and the high cost of machining reduced or eliminated. They also afford better bearing properties than cast materials. Where some porosity is allowed to remain they can be impregnated with a lubricant metal or oil. Also lubricant materials such as lead or graphite can be incorporated in the powder mixture prior to sintering.

By incorporating age hardening ingredients such as chromium, nickel silicide and the like in a copper powder mix, pressing, sintering and then heat treating to produce age hardening a material of high strength and hardness is produced. While these materials can be produced satisfactorily it requires great care in processing, elaborate precautions for protective atmospheres, rapid heating and the like. Otherwise a soft shell forms on the materials during sintering, which must be machined away or the article discarded. The shell is probably due to oxidation of one of the ingredients.

We have found that a composition of copper, nickel and phosphorus does not produce a soft shell during sintering. This material can be age hardened to produce a body of substantial hardness and strength.

Compositions of the present invention may contain:

	Per cent by weight
Nickel	0.5 to 5
Phosphorus	0.1 to 1
Copper	Balance

Small percentages of diluent ingredients may be present, such as up to 5% cadmium, up to 8% silver and up to 10% of zinc or tin.

It is also contemplated that a reducing agent may be added to the metal powder mixture to act as a de-oxidizer and provide a protective reducing atmosphere during sintering. This may preferably be a metal hydride, which will evolve

nascent hydrogen during sintering. The preferred metal hydride is titanium hydride in proportions ranging from 0.05% to 5% of the powder mixture. During sintering nascent hydrogen is given off leaving titanium as an alloying and hardening ingredient in the sintered body. Hydrides of other metals of the fourth and fifth group of the periodic table may be used in the same proportions instead of titanium hydride, such as:

- Zirconium hydride
- Hafnium hydride
- Thorium hydride
- Columbium hydride
- Tantalum hydride

The hydrides of the alkaline and alkaline earth metals are not as stable as those of the metals of the higher groups of the periodic table but may be used in like proportions instead of those previously mentioned if proper precautions are taken. They include the following hydrides:

- Calcium hydride
- Barium hydride
- Strontium hydride
- Sodium hydride
- Potassium hydride

These are quite hygroscopic and decompose rapidly into hydrogen and the corresponding hydroxide when left standing in air at room temperature.

The hydrides of the fourth group metals titanium, zirconium, hafnium and thorium are the most useful. These are stable at room temperature, non-hygroscopic, easy to handle and dissociate gradually during sintering.

The preferred composition range is:

	Per cent
Nickel	1.5 to 4
Phosphorus	.4 to 1
Copper	Balance

The preferred ratio nickel to phosphorus is 4:1 which corresponds approximately to the formula Ni₄P.

The phosphorus may be introduced as a 15% phosphor copper powder produced from shot by ball milling to -325 mesh. This is mixed with copper and nickel powders, and other ingredients, if any, and the mixture ball milled for at least 8 hours.

The mixed powders are then pressed into a suitable die at a pressure which may be in order of 30 tons per square inch. The pressed compact

is sintered in hydrogen for 1 hour at a temperature between 975° and 1000° C.

It is then usually advisable to repress the sintered blank, after cooling, in the same die at a higher pressure, such as 40 tons per square inch.

An age hardening treatment is then applied which may consist in first heating the body to a temperature of 975° C. to 1000° C. in hydrogen and holding the temperature for ½ hour to effect a solution of the nickel and phosphorus, or nickel phosphide, in the hopper. This is followed by quenching in water or oil and then aging at an elevated temperature such as 450° C. for several hours, such as 16 hours.

A mixture having the initial composition

	Per cent
Nickel -----	2.0
Phosphorus -----	0.5
Copper -----	Balance

resulted in a metal body which had a hardness of 53 Rockwell B and an electrical conductivity of 40% after aging. No soft skin was formed during sintering. The material was of good tensile strength and elongation properties.

The material is useful for bearings for internal combustion engines and other machinery and also for current carrying parts such as the bearing of seam welding rolls.

There are in general three classes of material which may be produced from compositions of the present invention depending upon the density to which the material is pressed. One class has a density, after sintering, repressing and aging of 8 to 8.5 grams per cc. This is a dense non-porous material of high strength, hardness and fatigue strength and is suitable for heavy duty bearings.

Another class of material has an intermediate density of between 7.5 and 8 gms./cc. and is characterized by the presence of discontinuous porosity together with substantial strength and hardness. This permits surface absorption of lubricants such as lead, thallium or other lubricant metals, or of oil or wax.

A third class has a final density of 5 to 7.5 gms./cc. and has a continuous network of pores

so that the entire body may be impregnated with a lubricant such as lead, thallium or other metal, or oil or wax. This material is weaker and generally requires a strong backing for support. For example the powders may be pressed against a steel back and sintered to it. The first two groups of materials may in some cases be used as a solid bearing or bushing which is pressed into the housing.

In addition to bearings the material may be used for wear resistant machine parts, valve guides, pressure exerting welding electrodes and electric contactors.

The phosphorus in these compositions has a cleansing action as well as an alloying action. It serves as a deoxidizer. It also improves the ductility and other physical properties of the metal bodies.

While specific embodiments of the invention have been described, it is intended to cover the invention broadly within the spirit and scope of the appended claims.

What is claimed is:

1. A bearing formed of a sintered and age hardened metal composition containing 0.5 to 5% nickel, 0.1 to 1% phosphorus, and the balance substantially all copper, said composition being characterized by relatively high strength and hardness and by the absence of a soft shell, said soft shell absence being due to the influence of said phosphorus.

2. A bearing formed of a sintered and age hardened metal composition containing 1.5 to 4% nickel, .4 to 1% phosphorus and the balance substantially all copper, the ratio of nickel to phosphorus being about 4:1, said bearing being characterized by the absence of a soft shell as the result of the influence of said phosphorus.

3. A sintered and age hardened metal composition containing 0.5 to 5% nickel, 0.1 to 1% phosphorus, and the balance substantially all copper, said composition being characterized by relatively high strength and hardness and by the absence of a soft shell; said soft shell absence being due to the influence of said phosphorus.

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